PROCESS FOR ELECTROCHEMICAL STRIPPING OF COMPONENTS

BACKGROUND AND SUMMARY OF THE INVENTION

[0001] This application claims the priority of International Application No. PCT/DE2004/002799, filed December 22, 2004, and German Patent Document No. 10 2004 002 763.3, filed January 20, 2004, the disclosures of which are expressly incorporated by reference herein.

[0002] The invention relates to a process for electrochemical stripping of components ~~according to the preamble of Patent Claim 1~~.

[0003] Components of a gas turbine such as the rotor blades are provided with special coatings to provide oxidation resistance, corrosion resistance or also erosion resistance on the surfaces. The components of gas turbines are subject to wear during operation of same and may be damaged in other ways. To repair damage, it is usually necessary to partially or completely remove and/or deplate the coating in the area of the component to be repaired. The removal and/or deplation of coatings is also referred to as stripping of coatings.

[0004] Referring to stripping methods, a distinction is made as to whether stripping is performed by mechanical means, chemical means or electrochemical means. Electrochemical stripping is based on the principle of electrolysis. In electrochemical stripping processes, a distinction is made among those that operate with the help of a 2-electrode system, a 3-electrode system or a 4-electrode system. The present invention relates to an electrochemical stripping process, preferably using a 2-electrode system.

[0005] ~~US~~ U.S. Patent No. 6,165,345 discloses an electrochemical process for stripping coatings from gas turbine blades based on a 2-electrode system. According to the method disclosed there, a turbine blade to be stripped is connected to the positive terminal of a voltage source, whereby a specially adapted electrode is connected to the negative terminal of same.

The shape of this electrode corresponds essentially to the shape of the turbine blades to be stripped and/or the shape of the area of the turbine blade to be stripped. The electrode, and at least the area of the turbine blade to be stripped, are immersed in a working medium, a direct voltage of 1V to 3V being applied per component to provide a current flow between 5A and 10A. The operating range of electrochemical stripping as defined by the applied direct voltage is constant during the entire stripping process according to ~~US~~ U.S. Patent No. 6,165,345.

[0006] The object of the present invention is to create a novel process for electrochemical stripping of components.

[0007] ~~This object is achieved by a method according to Patent Claim 1.~~ According to the invention, an operating point of the electrochemical process of stripping is determined under actual process conditions prior to the actual electrochemical stripping process and is determined anew, i.e., monitored continuously, during electrochemical stripping and optionally adjusted.

[0008] Within the meaning of the present invention, the operating point of electrochemical stripping is determined *in situ*, i.e., under actual process conditions of electrochemical stripping—and is monitored continuously during electrochemical stripping and optionally adjusted. It is possible in this way to adjust the operating point to variable process conditions and thus always work at an optimum stripping rate and/or deplating rate. The time required for stripping is thus reduced significantly. Due to the continuous monitoring and optional adjustment of the operating point during electrochemical stripping, the operating point is also adjusted with respect to the component to be stripped, and is in particular adapted to the degree of stripping already performed and thus to the associated change in chemical composition of same. The inventive process is thus characterized by a high selectivity in stripping, so that there is a low risk of damage to the components during stripping.

[0009] According to an advantageous development of the invention, a direct voltage potential is applied, whereby the direct voltage potential is increased until a measured polarization current reaches a maximum as a function of the direct voltage potential, whereby this maximum determines the operating point of the stripping process. During stripping, an alternating voltage is superimposed on the direct voltage potential, and a change in the polarization current or the polarization conductance, which is due to the superimposed alternating voltage, is measured, whereby the direct voltage potential is adjusted as a function thereof so that the polarization current remains at the maximum.

[0010] Preferred embodiments of the present invention are derived from the ~~dependent subclaims and the~~ following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] An exemplary embodiment of the present invention is explained in greater detail on the basis of the drawing, without being restricted thereto. ~~It shows in~~

[0012] Figure 1[[:]] illustrates a blade of a gas turbine that is to be stripped.

DETAILED DESCRIPTION OF THE DRAWINGS

[0013] Hereinafter, the inventive method is described by using the example of a gas turbine blade to be stripped. Figure 1 illustrates such a blade 10 of a gas turbine comprising a blade vane 11 and a blade footing 12. In the exemplary embodiment shown here, the entire blade 10, i.e., the entire surface area of the blade vane 11 and the blade footing 12, is provided with a coating 13. This coating 13 may be an oxidation-resistant, corrosion-resistant and erosion-resistant coating.

[0014] Within the meaning of the present invention, a method is now proposed for deplating and/or removing the coating 13 from the surface of the blade pan 11 and the blade footing 12, for example, to repair the blade 10. Within the meaning of the present invention, this is performed by an electrochemical process using a 2-electrode system.

[0015] For electrochemical stripping of the blade 10, the latter is connected to the positive terminal of a voltage source, whereas the control electrode and/or counter-electrode is connected to the negative terminal of the voltage source. The control electrode and/or counter-electrode and the blade 10 to be stripped are immersed in a working medium—in an electrolyte solution.

[0016] Different from a 3-electrode system, the 2-electrode system used here employs a sturdy metal electrode as the control electrode instead of a combined measuring electrode and control electrode. Such a sturdy metal electrode as the control electrode is much less sensitive to the stripping process and to environmental influences such as electromagnetic waves. The electrochemical stripping process thus becomes less susceptible to interferences and is thus more overall more stable.

[0017] It is within the meaning of the present invention to determine the operating point of the 2-electrode system, i.e., the operating point of electrochemical stripping, *in situ* prior to the actual electrochemical stripping and to determine ~~said~~ <u>the</u> operating point anew continuously during the stripping process, i.e., to monitor it and optionally adjust it. The term *in situ* is to be understood to mean that the operating point of electrochemical stripping is determined under actual process conditions, i.e., specifically in 2-electrode system. A measured polarization current and/or a measured polarization conductance is used as the control signal, i.e., criterion for determining the operating point of the electrochemical stripping. To do so, the procedure is as follows:

[0018] To determine the operating point of electrochemical stripping, a potentiostatic circuit for the working potential and/or for the control potential of the electrochemical stripping is created on the 2-electrode system, which means that a direct voltage potential is applied to the 2-electrode system. This direct voltage potential is then raised continuously or incrementally to determine the operating point for electrochemical stripping. The measured polarization current and/or the measured polarization conductance changes as a function of the applied direct voltage. Thus, in this way, a polarization-current/control-potential characteristic and/or a polarization-conductance/control-potential characteristic is determined.

[0019] The direct voltage is then increased until the first derivation of the polarization current as a function of the direct voltage potential, starting from positive values, assumes a value of zero and subsequently becomes negative, which means that the polarization current has reached a maximum and the polarization conductance assumes a value of zero. This value of the direct voltage potential, at which the polarization current assumes a maximum and/or at which the polarization conductance assumes a value of zero, serves as the operating point for electrochemical stripping. At this direct voltage potential, the electrochemical stripping proceeds at a maximum deplating rate or stripping rate. This determination of the operating point is system-specific, i.e., the ohmic resistance of the working medium, i.e., the electrolyte solution, is taken into account.

[0020] According to an advantageous development of the present invention, an alternating voltage is superimposed on the direct voltage potential determined during the electrochemical stripping. The alternating voltage preferably has a low voltage amplitude of preferably ± 5 mV. The change in the polarization current or the polarization conductance due to the superimposed alternating voltage is measured, and the direct voltage potential is modified as a function thereof, so that the polarization current remains at the maximum and/or the polarization conductance retains a

value of zero. At a negative polarization conductance, the control potential and/or the direct voltage potential is reduced; at a positive polarization conductance, the direct voltage potential is increased accordingly. This ensures that stripping is always performed at the maximum rate of removal, and that stripping is avoided within the range of the so-called breakdown potential. In this way, an optimal deplating rate can be achieved during the entire stripping process, and gentle stripping of the gas turbine blade to be stripped is always achieved.

[0021] It is also within the meaning of the present invention to use the values measured for the polarization current and/or the polarization conductance during the stripping process for definition of a termination criterion for electrochemical stripping. The measured values of the polarization current thus also contain information about the degree of stripping of the stripped component that has already taken place and/or about the structure of the coating to be deplated with the help of electrochemical stripping. The termination criterion for the electrochemical stripping is obtained from the relationship between the initial value and the values currently measured for the polarization current. This calculation is performed without stopping during the stripping and is thus performed continuously. If the polarization current assumes a value obtained from this calculation, the stripping process can be terminated as a function thereof.

[0022] The inventive process for electrochemical stripping is preferably used for stripping gas turbine blades. It is also suitable for stripping gas turbine blades having internal channels such as cooling channels. For stripping such gas turbine blades, as described above, the operating point of the electrochemical stripping is determined and monitored continuously during stripping and optionally adjusted. The stripping of the blade surfaces is performed in this way. If it is found on the basis of the continuously detected values for the polarization current that the stripping process on the surface of the gas turbine blade has been terminated, then

according to this invention, the control potential is increased into a passive range for the blade surface. Because of the small diameters of the channels arranged inside the gas turbine blade, there is a shift in the control potential for the channels to an active range, so that stripping can also be performed within the channels in this way. During stripping of the blade surfaces, there is no stripping of the channels.

[0023] The present inventive process for electrochemical stripping of components is characterized by a high selectivity of the stripping process. The operating point of electrochemical stripping is adjusted continuously and thus the electrochemical stripping can always be performed at the optimal deplating rate. The inventive process is more rapid and less expensive than the stripping processes known from prior art. Due to its high selectivity, there is a minimal risk of damage to the components during stripping.

[0024] Referring to the inventive electrochemical stripping process, highly diluted acids are used as the electrolyte solution, i.e., the working medium. To this extent, only a minimum of safety measures and a minimum of time and energy are required for disposal of the working medium.

[0025] The inventive stripping process can be integrated in line production. The inventive process is also insensitive to so-called local elements on the surface of the component to be stripped, which ~~said~~ elements can develop due to significant differences in wear and/or damage to the coating on the surface of the component to be stripped.

[0026] Finally, it should be pointed out that for the most accurate possible adjustment and/or control of the operating point for electrochemical stripping, the control potential, i.e., the direct voltage potential, should not be tapped directly on the current carrying lines but, instead, should be tapped via a separate line. Voltage losses by the current-

carrying lines can be eliminated in this way. The operating point can be determined and adjusted more accurately.